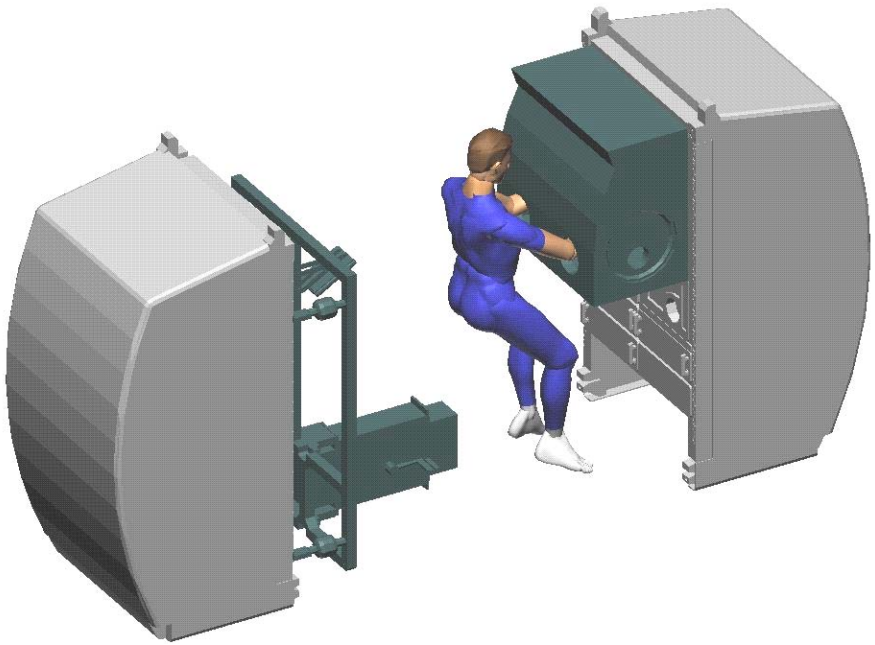
International Space Station

Internal Volume Configuration



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ISS Internal Volume Configuration Working Group

Todd Hellner
December 12, 2002

IVCWG Established in July 2000

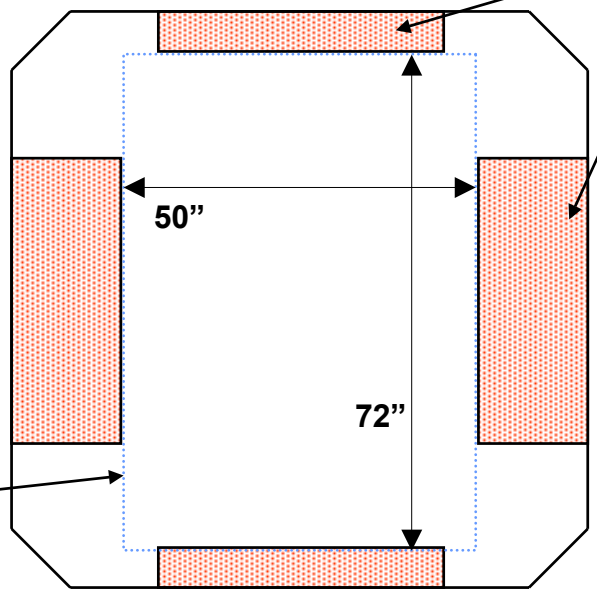
- Manage ISS Interior Volume
  - Coordinate use of ISS interior volume and report to ISS Program Office
- Develop & Manage IVC Constraints
  - Develop a coordinated set of measurable constraints
- Publish the ISS Interior Configuration Document
  - Control internal configuration and provide location commitments to hardware
  - Describe ISS' internal environment stage-by-stage to hardware designers, MOD, flight crew, etc.
- Provide Requirements Verification
  - Analyze ISS interior using documented IVC constraints & publish results

IVC Processes

1) Bound hardware protrusions:

Payload rack protrusion limits:

- 6" @ floor & ceiling
- 17" @ walls



Desired 50" x 72" corridor

Module corridor cross-section

If all hardware met the protrusion boundaries documented for payload racks, there would be no conflicts or concerns about free corridor volume…however,

- These design boundaries don't currently apply to non-payload hardware
- These design boundaries don't currently apply to non-rack hardware
- These design boundaries have been waived even on payload rack hardware

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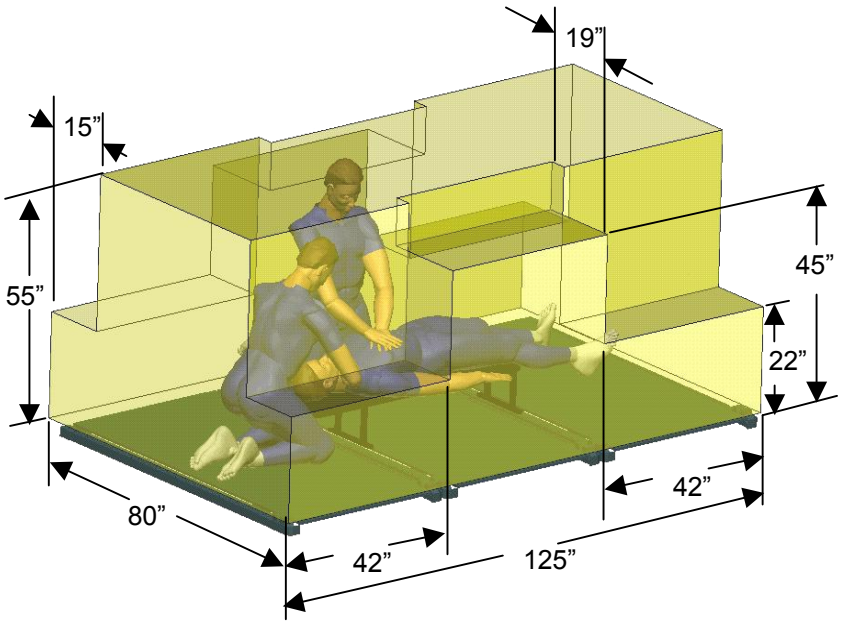
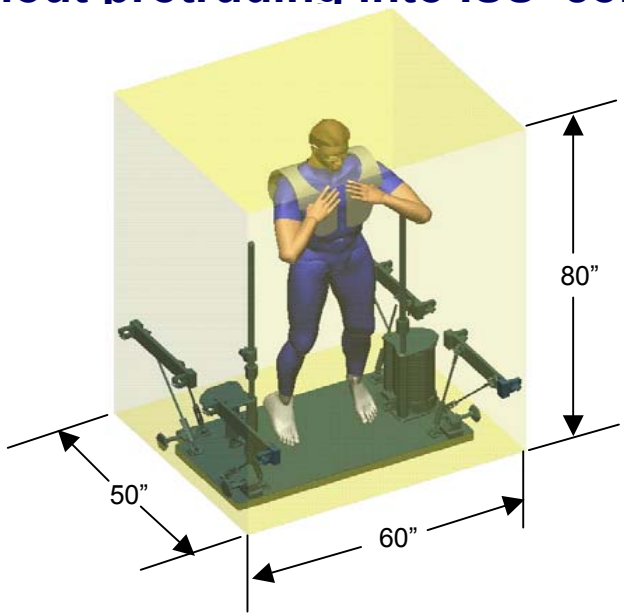
It's not realistic to eliminate all hardware protrusions

Some functions can't be accommodated without protruding into ISS' corridors



VOLUME PROTECTED FOR EMERGENCY CPR



VOLUME FOR RESISTIVE EXERCISE

To identify and potentially control protrusions when they are first being planned, the IVC team has started participating in hardware design reviews

- **If hardware changes aren't possible, accommodation into the integrated environment is usually addressed by changing an item's location or flight-schedule**

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The reality is that…

Racks have bump-outs, like the Temporary Sleep Station (TeSS)…

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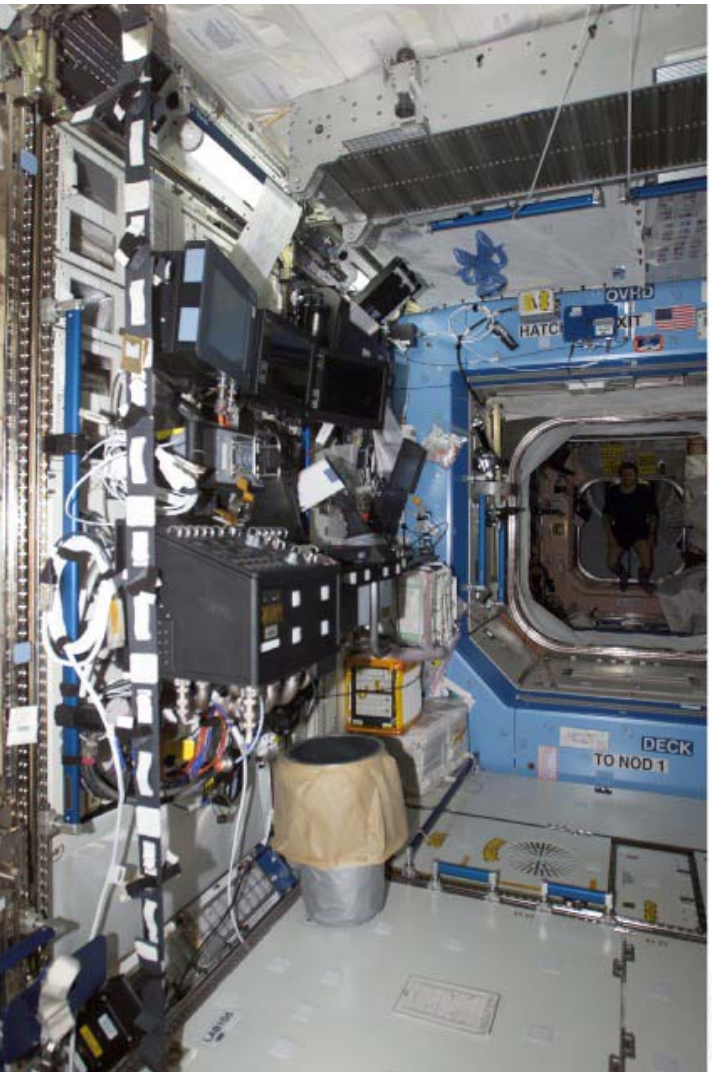
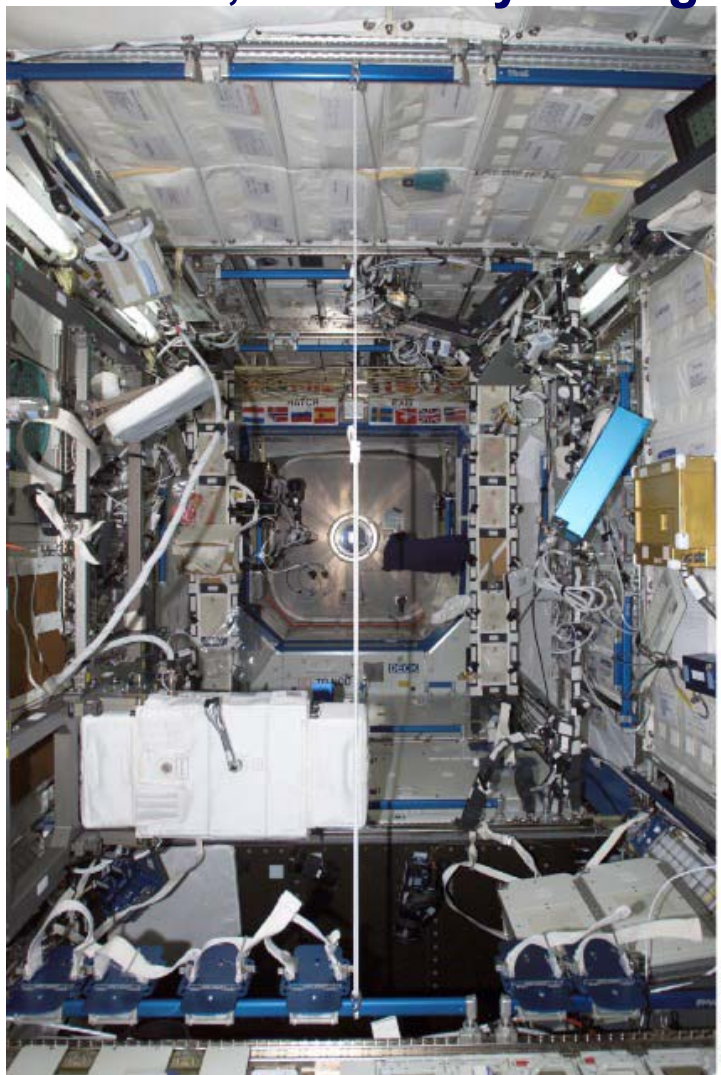
Racks have protrusions, like the Robotics Work Station



Large non-rack items rely on using ISS' free volume in corridors, like the Cycle Ergometer



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Not to mention…

Small experiments in the aisles

Cable routing issues

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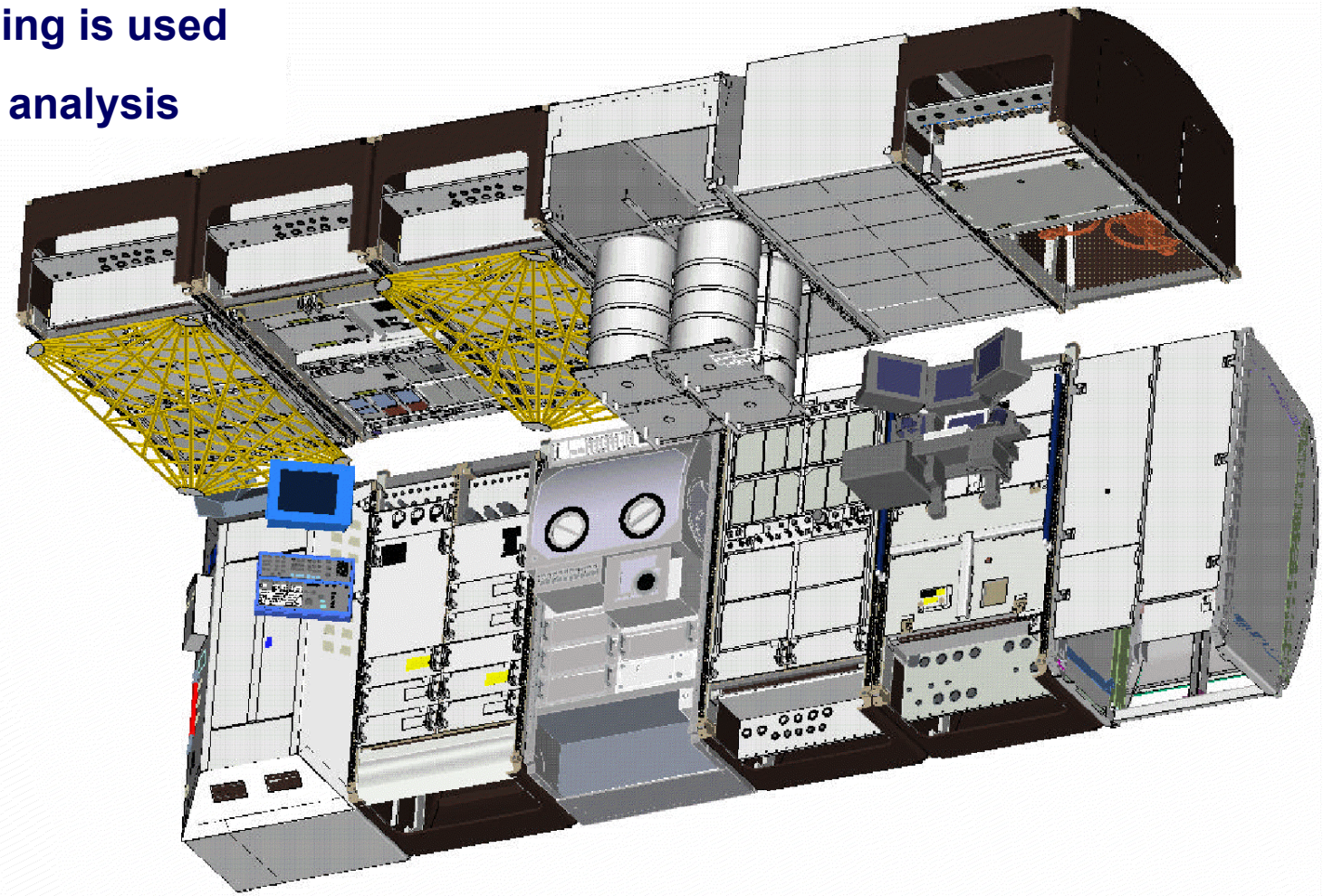
Loose stowage

Small equipment

IVC Processes (cont'd)

2) Analyze stage configurations

3-D CAD modeling is used for IVC graphic analysis



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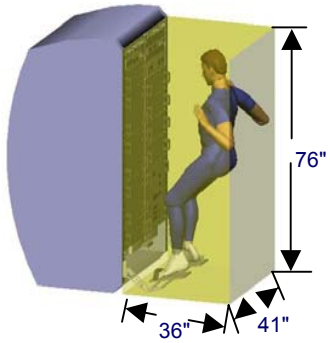
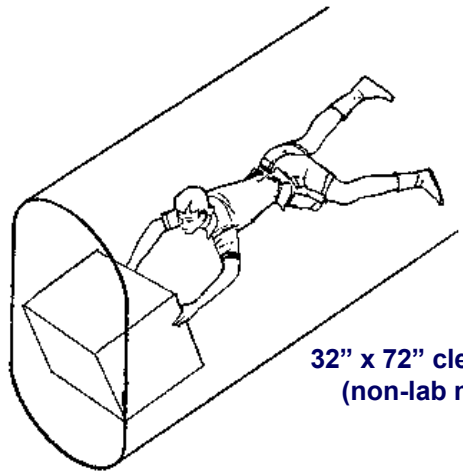
To support CAD analysis, the IVC team negotiated and documented volumetric "stay out zones" or constraints for all identified hardware and/or operations

- **Operational volumes**



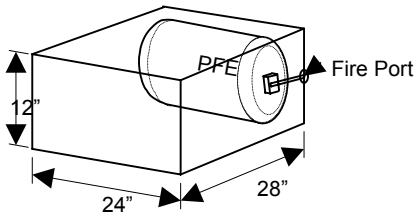
- **Emergency egress and freedom to move**



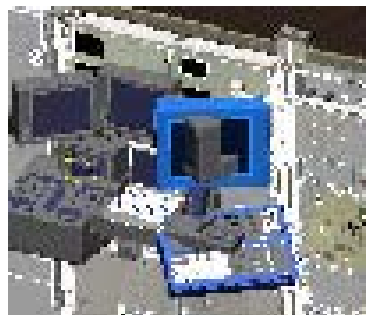
32" x 72" clear corridor (non-lab modules)

- **Access to critical equipment**

CLEARANCE ZONE FOR FIRE EXTINGUISHER



- **Hardware-to-hardware conflicts**



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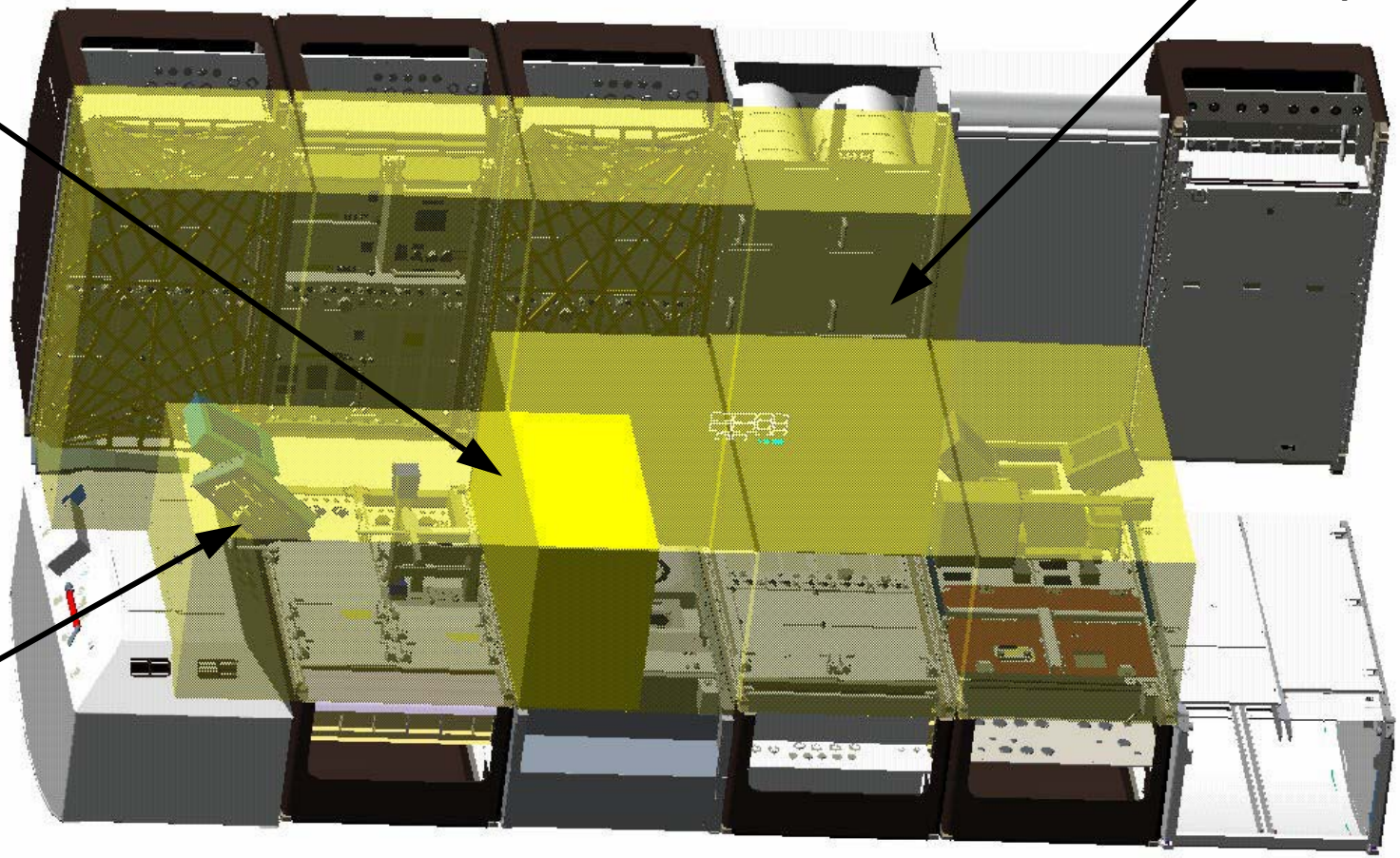
Apply the stay-out zone constraints to the model of the integrated environment

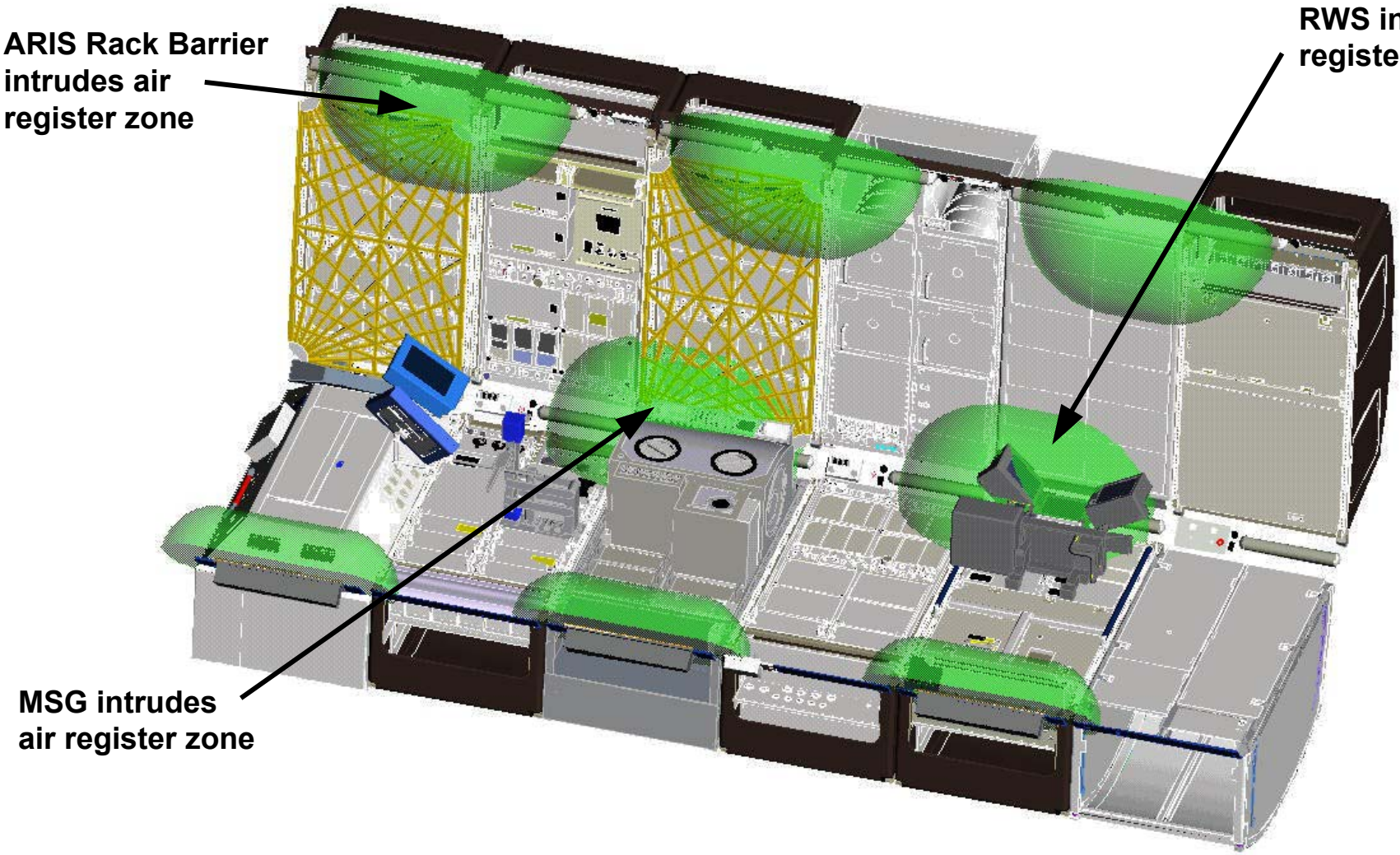
MSG worksite overlaps with HRF#1, ER#3, and ER#5

MELFI worksite overlaps with ER#5



HRF#1 worksite overlaps with ER#1, 2, & 3

Apply the stay-out zone constraints to the model of the integrated environment



IVC Processes (cont'd)

3) Document and negotiate closure on all identified exceptions

- Documentation supports Certificate for Flight Readiness (CoFR)
- The IVC Working Group (IVCWG) meets to review each stage analysis
- A consistent closure approach is pursued
  - Exceptions are divided into categories, for example:
    - Conflicts that can be resolved by scheduling
    - Violations of a singular subsystem's constraints
    - Violations of constraints "owned" by a single responsible organization
  - Parties responsible for addressing each category are documented in an ISS IVC Verification Plan
- Higher level boards address issues that can't be resolved in the IVCWG
  - Options:
    1) Eliminate offending hardware
    2) Modify hardware design
    3) Revise the ISS topology
    4) Change the hardware flight schedule

Lessons Learned

- **Other, more comprehensive integration approaches may be more effective, but the IVC/IVCWG approach has been successful while minimally impacting existing processes**
  - **The IVC/IVCWG was created at a relatively late stage of the Program's development**
  - **Future Programs should address integration processes for human-occupied volume from the earliest stages of Program design**

- **Initially limited in its scope, the IVC/IVCWG integration approach may be expanded to include or integrate with additional Station processes or concerns, for example:**
  - **Excess non-standard stowage outside of identified stowage locations**
  - **International Partner modules**
  - **Small items in the environment, particularly the cumulative affect of**
  - **Cable management**
  - **Additional safety, human factors, systems functionality or other constraints**

- **Better feedback on Station's true real-time configuration should be incorporated into IVC processes**
  - **Current process focuses only on pre-mission planning**
  - **Real-time data would provide feedback on how successful the IVC/IVCWG is performing**